DECHANT SIMULATION –ACUTE:CHRONIC WORKLOAD RATIOS OF A RELIEVER ACROSS VARIOUS CHRONIC AND ONE DAY WORKLOADS

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INTRODUCTION

This report details simulated acute:chronic ratios (ACR) across various one-day workloads and chronic workloads of a NCAA D1 reliever. The results are generated using previously gathered workload data from the pitcher's motusTHROW usage.

Ultimately, this serves as an individual guide for the pitcher to determine an appropriate inning limit. This guide also aides in determining an optimal future throwing program to safely raise their chronic workload.

METHODS

The subject analyzed has been using the motusTHROW IMU compression sleeve for the past 28 days during all throwing activity including practices and intersquad competition. For each throw, the mtousTHROW IMU calculates peak valgus torque on the throwing elbow. Throw-by-throw data were exported from the for the subject and were analyzed using Motus Global's proprietary workload algorithms.

Given the subject's current workload regimen, ACR's were computed under various future loading conditions. The loading conditions were varied by stepping the one-day workload from 0-28 and by stepping the chronic workload from 2-11, resulting in 130 calculations of resulting ACR's.

Data Processing & Analysis

To compute the various workload measures, first, the workload of each throw was computed. This was done by normalizing valgus torque by height and weight, and by then exponentially weighting the normalized value (equation 1).

$$WL_{throw} = \left(\frac{\tau_{vaglus}}{ht*wt}\right)^{1.3} \quad (1)$$

Next, daily workloads were computed as the total sum of workload of each throw (equation 2).

$$WL_{Day} = \sum_{throw=1}^{throw=n} WL_{throw} \quad (2)$$

Next, acute workloads were computed as a rolling seven day average of daily load (equation 3).

$$WL_{Acute} = \frac{1}{7}\sum_{day=1}^{day=7} WL_{day} \quad (3)$$

Next, chronic workloads were computed as a rolling twenty-eight day average of daily load (equation 4).

$$WL_{Chronic} = \frac{1}{28}\sum_{day=1}^{day=28} WL_{day} \quad (4)$$

Finally, the ACR was computed as the acute workload divided by the chronic workload (equation 5).

$$ACR = \frac{WL_{acute}}{WL_{chronic}} \quad (5)$$

RESULTS AND DISCUSSION

The resulting ACR's from the simulation are presented in Figure 1, below. ACR's below a 1.3 have been found to associated with the lowest risk of injury and are color coded to green.[1]

One Day Workload \ Chronic WL	2	3	4	5	6	7	8	9	10	11
0	3.2	2.1	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.6
2	3.3	2.2	1.7	1.3	1.1	1.0	0.8	0.7	0.7	0.6
4	3.5	2.4	1.8	1.4	1.2	1.0	0.9	0.8	0.7	0.6
6	3.6	2.5	1.9	1.5	1.2	1.1	0.9	0.8	0.7	0.7
8	3.8	2.6	1.9	1.6	1.3	1.1	1.0	0.9	0.8	0.7
10	3.9	2.7	2.0	1.6	1.4	1.2	1.0	0.9	0.8	0.7
12	4.1	2.8	2.1	1.7	1.4	1.2	1.1	0.9	0.8	0.8
14	4.2	2.9	2.2	1.8	1.5	1.3	1.1	1.0	0.9	0.8
16	4.3	3.0	2.3	1.8	1.5	1.3	1.1	1.0	0.9	0.8
18	4.5	3.2	2.4	1.9	1.6	1.4	1.2	1.1	0.9	0.9
20	4.6	3.3	2.5	2.0	1.6	1.4	1.2	1.1	1.0	0.9
22	4.8	3.4	2.5	2.0	1.7	1.5	1.3	1.1	1.0	0.9
24	4.9	3.5	2.6	2.1	1.8	1.5	1.3	1.2	1.1	1.0
26	5.1	3.6	2.7	2.2	1.8	1.6	1.4	1.2	1.1	1.0
28	5.2	3.7	2.8	2.2	1.9	1.6	1.4	1.2	1.1	1.0
30	5.3	3.8	2.9	2.3	1.9	1.6	1.4	1.3	1.2	1.0
32	5.5	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.1
34	5.6	4.1	3.1	2.4	2.0	1.7	1.5	1.4	1.2	1.1

Table 1. Heatmap of ACR under various loading conditions with varied one-day workloads and chronic workloads for the POI.

The resulting heatmap in Table 1 shows that higher chronic workloads allow for a pitcher sustain higher one-day workload with a less elevated ACR. This is critical in reducing injury risk.

Further context can be gathered from this pitcher's data by converting the one-day workloads into the pitcher's typical game-day activies. To do this, data were post-tagged by using time-stamps on a day of competition.

The pitcher's game day was broken down into three categories, pre-game Longtoss, pre-game Bullpen, and the 23-pitch Inning. Total workloads were computed for each category and are found in Table 2.

Game-day Activity	Workload
Pre-Game Longtoss	2.57
Pre-Game Bullpen	3.87
23 Pitch Inning	5.22

Table 2. Game-day activity workload levels of the POI.

These workload tags were the used to convert a one-day workload allotment in Table 1, into an inning limit. This was done by subtracting the pitcher's pre-game longtoss and bullpen workload from the one-day workload value, and then by dividing the remainder by the typical inning workload value. The resulting Inning Conversion is also compared to a calculated ACR, given the pitcher's current chronic workload of 7.0.

One Day Workload	Minus Pregame LT/BP	Inning Conversion	Resulting ACR (CHR = 7)
0	-6.4	0.0	0.9
2	-4.4	0.0	1.0
4	-2.4	0.0	1.0
6	-0.4	0.0	1.1
8	1.6	0.3	1.1
10	3.6	0.7	1.2
12	5.6	1.1	1.2
14	7.6	1.4	1.3
16	9.6	1.8	1.3
18	11.6	2.2	1.4
20	13.6	2.6	1.4
22	15.6	3.0	1.5
24	17.6	3.4	1.5
26	19.6	3.7	1.6
28	21.6	4.1	1.6
30	23.6	4.5	1.6
32	25.6	4.9	1.7
34	27.6	5.3	1.7

Table 3. Converted Workloads- Inning Value & Resulting ACR

The data in Table 3 shows the resulting ACR given the number of innings thrown by the POI given his current workload status (chronic workload = 7.0). The subject can currently withstand 1.8 innings, while keeping the ACR below or equal to a 1.3. Throwing more than 2 innings may place the pitcher at an increased risk of injury. If the pitcher is able to build a chronic workload of over 9.0, they would be able to tolerate 4.9 innings of competition with a minimal spike in ACR.

To build a chronic workload effectively, a simulation was run for the subject, assuming a 20% growth in daily workload from week-to-week on a 6-day/week throwing schedule. Seen in Figure 1, this growth rate kept the AC Ratio below a 1.3, and gradually allows for the build up of chronic workload over a 30 day period.

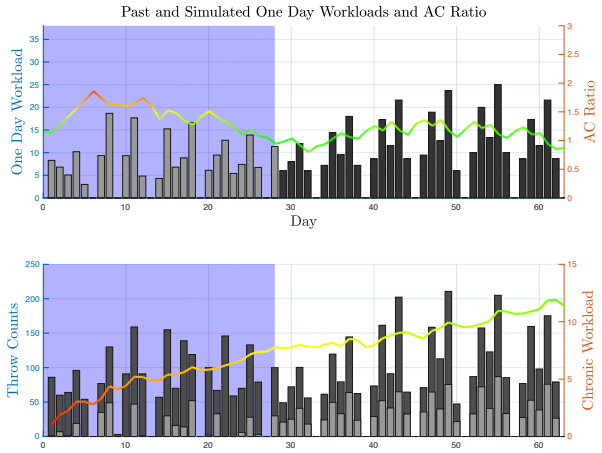

Figure 1. Projected workloads to build chronic workload. The blue area represents actual data, while the white area represents future simulated data. The top graph contains one-day workloads and ac ratios, and the bottom graph shows converted total and high effort throw counts, and chronic workload.

CONCLUSION

The workloads captured and simulated for a NCAA D1 reliever show that a higher chronic workload allows for the pitcher to perform with larger one-day workloads while minimizing the ACR.

Currently, the pitcher can safely withstand 1.8 innings of competition. If the pitcher increases their chornic workload by 30%, the pitcher will be able to safely withstand 4.9 innings of competition.

REFERENCES

1. Mehta, Sameer "*Investigating the relationship between workload and throwing injury in elite, baseball athletes*" Physical Therapy in Sport v28 pE3:4, November 2017